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Andriy KAMINSKYI
Taras Shevchenko National University of Kyiv
https://orcid.org/0000-0002-6574-8138
e-mail: kaminskyi.andrey@gmail.com
Denys BUTYLO
Taras Shevchenko National University of Kyiv
https://orcid.org/0000-0002-2466-4499
e-mail: dbutylo@gmail.com

ANALYSIS OF THE EFFECTIVENESS OF APPROACHES TO DETERMINING THE CAPITAL REQUIREMENTS FOR COVERING INVESTMENT RISKS IN PORTFOLIOS WITH INCLUSION OF ALTERNATIVE INVESTMENTS AND CRYPTOCURRENCIES

The article delves into evaluating the capital requirements of institutional investors for managing the risks in portfolios encompassing alternative investments and cryptocurrencies. It scrutinizes the progression of risk management approaches, particularly the unique challenges posed by alternative assets and digital currencies. In this study, Conditional Value at Risk (CVaR) is established as a principal indicator for assessing capital requirements for investment risk coverage. Portfolios are formulated based on principles of risk minimization, return optimization per unit of risk, and categories of traditional assets, alternative assets, cryptocurrencies, and their various combinations. This varied approach permits an extensive exploration across different investment scenarios and strategies. Following portfolio formations, we delve into the examination of diverse econometric and mathematical tools, including the Historical Method, Parametric Method, Cornish-Fisher Method, Monte Carlo Method, GARCH (Generalized Autoregressive Conditional Heteroskedasticity), EWMA (Exponentially Weighted Moving Average), and paired copula constructions method. Each method is scrutinized for its efficacy and precision in determining risks within these diverse portfolios. The study culminates by identifying the most efficient methodologies under varying market conditions. The focus is placed on the advantages of the copula approach in estimating investors' needs for capital to cover risk. This insight is crucial for investors and portfolio managers to tailor their risk management strategies, aligning with the evolving and dynamic nature of the investment markets. It underscores the significance of a multifaceted approach in understanding and minimizing investment risks, contributing to more informed and strategic decision-making in investment risk management.

Keywords: alternative assets; Conditional Value at Risk (CVaR); risk management; cryptocurrencies; regression data analysis; copulas.

Андрій КАМІНСЬКИЙ, Денис БУТИЛО
Київський Національний університет імені Тараса Шевченка

АНАЛІЗ ЕФЕКТИВНОСТІ ПІДХОДІВ ДО ВИЗНАЧЕННЯ ПОТРЕБ У ПОКРИТТІ ІНВЕСТИЦІЙНОГО РИЗИКУ ПОРТФЕЛІВ ІЗ ВКЛЮЧЕННЯМ АЛЬТЕРНАТИВНИХ ІНВЕСТИЦІЙ І КРИПТОВАЛЮТ

У статті проаналізовано використання підходів до оцінки потреб інституційних інвесторів у покриття ризиків портфелів з включенням альтернативних інвестиційних активів та криптовалют. Досліджується розвиток підходів до управління інвестиційними ризиками, з акцентом на унікальні виклики та методології, пов'язані з альтернативними активами та цифровими валютами. Стаття оцінює різні економетричні та математичні інструменти, зосереджуючись на їх застосовності та точності у визначенні ризиків в контексті портфелів з включенням альтернативних інвестиційних активів та криптовалют як окремого їх класу. Результати дослідження надають уявлення про оптимізацію стратегій управління ризиками для комбінованих портфелів та пропонують комплексний підхід до розуміння та мінімізації інвестиційних ризиків у цій динамічній галузі в контексті різних типів портфелів, залежно від обраної інвестором стратегії.

Ключові слова: альтернативні активи; Conditional Value at Risk; управління ризиком; криптовалюти; регресійний аналіз; копули.

Formulation of the problem in a general form and its connection with important scientific or practical tasks

In the contemporary stock market, a persistent trend of expanding the investment spectrum is observed, driven by the growing needs of investors. Traditional assets such as stocks, bonds, and cash equivalents are now actively complemented by alternative assets, including cryptocurrencies. One factor contributing to the increased demand for such assets and simultaneously providing their supply is the widespread adoption of Exchange Traded Funds (ETFs). This instrument allows investors to operate with alternative investment assets based on stock market principles, which are familiar and convenient for investors. It creates broader opportunities for combining traditional and alternative assets to build diversified investment portfolios. However, these portfolios generate new challenges related to investment risk management, as dependencies between the returns of traditional and alternative assets are often low or divergent. One of the key methods of risk management is the assessment of capital needs for its coverage. This is a crucial element in portfolio management, especially when dealing with assets like alternative investments and cryptocurrencies, characterized by significant volatility, complicating accurate forecasting and quantitative risk assessment. Such volatility becomes especially pronounced in the context of market shocks, like during the COVID-19 pandemic, which saw significant market fluctuations. Under these conditions, classic risk assessment methods, typically effective for more stable traditional assets, may be ineffective for alternative investments and cryptocurrencies. In this context, the use of regression analysis and copulas can be particularly helpful. Regression analysis helps to identify and quantitatively assess dependencies between the returns of different assets and external factors affecting the market. Copulas, on the other hand, allow for modeling complex dependencies between random variables, enabling more flexible and accurate analysis of interrelationships between various assets, especially in the tails of distributions. Thus, these methods can significantly improve the quality of risk assessment and determination of capital needs to cover these risks.

Analysis of Recent Research and Publications

Recent publications have explored the topic of alternative investment assets by M. Anson [1], L. Swedroe, D. Kizer [2], and V. Debski [3], who presented varying perspectives on defining the concept of alternative investment assets. A. Dorsey [4], D. Chorafas [5], F. Stefanini [6], T. Schneeweis, and D. Pescatore [7] developed their classifications of assets falling into this category. In their works, K. Leitner [8] and E. Sokolowska [9] highlighted the peculiarities of such investment instruments. Review of alternative assets as an investment class is widely represented in contemporary literature. Mundi and Kumar provide a quantitative bibliometric analysis and thematic analysis of the existing literature on alternative investments [10]. Narrowing the focus to the investment aspect of combining traditional and alternative assets, the work of Fischer and Lind-Braucher [11] is noteworthy. A comprehensive discussion of the role of alternative assets in investment portfolio construction approaches is presented in the article by John Mulvey and Woo Chang Kim [12]. Andrew Clark provide comparative analysis of the use of alternative investments for retail investors, wealth management clients, and institutional investors [13]. Roya Darabi and Mehdi Baghban analyze the modeling of dependency in returns on investment in copper and gold. The author argues that copulas provide better results for risk assessment [14]. Allen, McAleer and Singh applying Vine copula to Risk Measurement and Risk Modelling [15]. The issue of capital requirement for covering portfolio risk has been studied by N.A. Pancost, R. Robatto,[16] D. Corbae, and P. D'Erasmo [17].

Identification of Previously Unresolved Parts of the General Problem Addressed by the Article

At the same time, the issue of choosing the most accurate approach for determining investors' capital needs for risk coverage remains inadequately studied, especially in the context of alternative investments and cryptocurrencies.

Formulation of the Article's Objectives

The aim of this article is to investigate the effectiveness of various approaches to risk management in portfolios including alternative assets, particularly cryptocurrencies. The primary task in achieving this goal is to compare the results of capital needs assessment for risk coverage, determined through various econometric and mathematical tools, including copulas.

Presentation of the Main Material

The alternative investment market has demonstrated growth over the past decade. For instance, the research company Preqin [18] claims that the overall value of alternative assets more than doubled between 2015 and 2021 and is projected to reach $23 trillion by 2026 (representing 12% of the global investment market in 2021). The growth occurs both overall and within each specific class of alternative investment assets. According to the specialized platform Propel(X) [19], the average return on such assets is 9% annually.

In literature, two main approaches are most commonly used to define alternative assets. The first approach involves defining alternative assets from an "excluding" perspective: alternative investment assets are those that do not belong to traditional asset classes (stocks, bonds, and depositary bank instruments) [9]. The second approach defining alternative assets from an "including". In particular, five main groups of alternative investments are identified: real assets, hedge funds, commodities, private equity, and structured products [3].

As mentioned earlier, investing in alternative assets is complicated for investors due to the partial connection with physical assets. This has led to the creation of a special investment instrument - Exchange-Traded Fund (ETF), which formally corresponds to traditional stock assets in operational management. These funds provide investors with the opportunity to access various markets and sectors by investing in a single financial instrument that represents a diverse portfolio of assets. One of the key advantages of using ETFs for investing in alternative assets is easy access to these markets without the need for direct acquisition or management of individual assets. This makes investing in alternative assets more accessible and convenient for a wide range of investors, as ETFs are traded on the stock exchange and can be bought and sold just like shares of traditional companies.

To analyze interdependencies between traditional and alternative investment assets, S&P agency indices representing each category were used. Using indices only from S&P allows you to get a comprehensive view of the stock market through the use of standardized and widely recognized indicators that reflect the movements of various sectors and companies as a whole. We chose 3 indices representing traditional assets and 9 alternative ones. 2 of these 9 ETFs represent a separate class of alternative investments - cryptocurrencies Full list can be found in Table 1 [20].

For our study, we used daily data from 2017 to 2019. This selection was based on several objective factors that determined the optimality and adequacy of the investigated time frame. Although weekly data is less prone to disturbances, the use of daily data is necessary to generate a sufficient number of observations in the sample, since cryptocurrencies are relatively new financial instruments in the market. Also, the selected period is characterized by relative economic stability and lacks anomalous periods, such as unforeseen financial or economic crises, like the COVID-19 pandemic.

The main purpose of supplementing the portfolio with alternative assets is risk diversification. This characteristic of alternative assets implies that their price movements may respond differently to economic and market fluctuations in comparison to conventional assets. Cryptocurrencies, in particular, occupy a special place in the context of diversification due to their unique characteristics and market behavior, distinct from traditional financial instruments. The integration of such assets into investment portfolios is a strategic approach to mitigate overall risk. This divergence in response is attributed to the distinct nature of the revenue streams associated with alternative assets. Due to their unique origins and the diversity inherent in these asset types, alternative investments often demonstrate reduced correlation with traditional asset classes, indicating a lesser dependency on the market dynamics of stocks and bonds. Consequently, investors leverage alternative investments as a tool to diversify their portfolios across various asset classes. This strategy not only curtails overall portfolio risk but also enhances the potential for profit under diverse market conditions. A crucial aspect of this approach involves analyzing the degree of correlation between selected indices, both individually and collectively, across 'traditional' and 'alternative' categories. This emphasizes the necessity of a nuanced understanding of the interplay between different asset classes, as represented in Table 1.

Table 1

Correlation matrix of ETFs represented traditional and alternative assets (calculated by the author)

	S&P 500	**S&P 600**	**S&P 400**	**S&P GSCI**	**S&P REIT**	**S&P Precious Metals**	**S&P Energy & Metals**	**S&P Oil & Gas**	**S&P Private Equity**	**S&P Agriculture**	**S&P Bitcoin**	**S&P Ethereum**
S&P 500	100,00%											
S&P 600	83,72%	100,00%										
S&P 400	90,92%	95,82%	100,00%									
S&P GSCI	28,45%	26,81%	30,15%	100,00%								
S&P REIT	47,12%	42,25%	48,33%	9,71%	100,00%							
S&P Precious Metals	-11,65%	-12,61%	-12,38%	9,67%	4,01%	100,00%						
S&P Energy & Metals	27,50%	25,79%	28,89%	98,59%	9,81%	9,90%	100,00%					
S&P Oil & Gas	57,48%	61,68%	63,91%	67,92%	20,69%	-1,06%	67,75%	100,00%				
S&P Private Equity	72,95%	69,13%	73,42%	30,01%	30,87%	-3,20%	28,63%	47,65%	100,00%			
S&P Agriculture	8,57%	8,67%	10,31%	31,04%	0,96%	5,42%	16,55%	15,90%	12,09%	100,00%		
S&P Bitcoin	1,25%	0,54%	-0,73%	-1,48%	-3,51%	4,34%	-1,60%	0,01%	3,87%	2,62%	100,00%	
S&P Ethereum	4,67%	3,98%	2,49%	2,54%	-3,77%	5,79%	2,53%	2,08%	10,42%	1,64%	59,12%	100,00%

Correlations between assets are calculated based on the daily return of the aforementioned ETFs for a 2017-2019. Thus, the average correlation between traditional indices was 0,9015. At the same time, this indicator for exclusively alternative assets (excluding cryptocurrencies) is 0,2443. The correlation index between traditional, alternative assets and cryptocurrencies is 0.0188. The average indicator for the entire sample is 0,2386. This indicates not only a significantly lower dependence between traditional and alternative investment assets as a whole, but also the multidirectional nature of returns between individual classes of alternative assets.

The observed low correlations indicate a minimal dependency between the returns of alternative and traditional assets. Particularly noteworthy is the near absence of correlation between these asset classes and cryptocurrencies, rendering this class of alternative investments even more distinctive in the context of our study. This unique characteristic underscores the necessity to consider specific methods for calculating investors' capital requirements to cover risks, taking into account the low dependencies among portfolio components. This approach necessitates a tailored analytical framework, one that acknowledges the distinct behavior of cryptocurrencies in contrast to more conventional asset classes. Such a framework would enable a more nuanced understanding of risk diversification and capital allocation strategies in the face of evolving market dynamics.

Capital requirements in the context of portfolio investments refer to the minimum amount of capital that investors need to hold to cover the risks associated with their investment portfolios. These requirements are a critical aspect of financial regulation, designed to ensure that investment funds or financial institutions have sufficient capital to absorb potential losses and remain solvent, especially during periods of market volatility or downturns. In the realm of portfolio investments, capital requirements are often dictated by regulatory frameworks, which may vary depending on the jurisdiction and the nature of the investments. These regulations typically consider various risk factors, including market risk, credit risk, and liquidity risk, associated with different types of assets in a portfolio. For instance, riskier investments like certain alternative assets might necessitate higher capital requirements due to their potentially higher volatility and uncertainty. From an investor's perspective, understanding and adhering to capital requirements is crucial for effective risk management. It involves not only complying with regulatory standards but also adopting internal risk assessment mechanisms to determine the appropriate level of capital needed to safeguard against potential losses. This process is integral to maintaining financial stability and confidence in the investment market, especially for institutions that manage substantial portfolios with diverse asset classes. Effective capital allocation, in line with capital requirements, also enables investors to optimize their return on investment while maintaining a buffer against unforeseen market movements. It's a balancing act that requires careful analysis of the risk-return trade-off and strategic planning to ensure that the portfolio aligns with both investment goals and regulatory obligations.

Many institutional investors meticulously formulate portfolio structure requirements, guided by a range of strategic considerations and regulatory constraints. These entities, which include pension funds, insurance companies, and sovereign wealth funds, often adhere to specific investment guidelines that dictate the composition and risk profile of their portfolios. These guidelines are tailored to align with the investors' risk tolerance, investment horizon, and overall financial objectives, ensuring a balanced approach to asset allocation and risk management. There exist various restrictions on the proportion of alternative investments, cryptocurrencies, and other such assets within these portfolios. For instance, certain institutional investors may have a cap on the percentage of their portfolio that can be allocated to alternative investments, including real estate, private equity, and hedge funds. This is due to the inherent risks and liquidity concerns associated with these asset classes. Similarly, the volatile and relatively unregulated nature of cryptocurrencies often prompts investors to impose stringent limits on their inclusion in portfolios, if they are considered at all.

Given these constraints, it becomes pertinent to examine three distinct types of portfolios, each representing a different asset class: traditional assets, alternative investments, and cryptocurrencies. Additionally, we will consider two combined portfolios from these three asset classes: a combined portfolio of traditional and alternative assets (with a mandatory share of 50%+ in traditional assets) and a similar portfolio, but with the possibility of expansion through cryptocurrencies. We will explore two approaches to optimizing the described portfolios. The first will involve forming a portfolio with minimum risk. One of the key tools for analyzing portfolios is the Markowitz model, which allows you to determine the optimal balance between risk and profitability based on statistical data on the movement of asset prices. This model is used to construct efficient sets of portfolios representing different combinations of assets [21].

After determining the characteristics of individual assets, we proceed to the construction of the two-factor Markowitz optimization problem [21]. With the help of this optimization, we determine the portfolio that minimizes the risk (standard deviation of the return) at a given level of return.

The Markowitz model is based on a quadratic formula for portfolio risk:

$$\sigma^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \sigma_i \sigma_j p_{ij} \quad (1)$$

σ^2- the variance of the portfolio;
w_i та w_j – the weights of assets in the portfolio;
σ_i та σ_j – the standard deviations of individual assets;
p_{ij} – the coefficient of covariance between assets.

A practical calculation of the shares of each asset in the portfolio with the lowest risk is carried out with the help of the "Solver" add-in for Microsoft Excel, based on the above-mentioned Markowitz approach.

The second approach involves the formation of what is termed an "optimal" portfolio. We optimized investment portfolios of relevant samples using the Sharpe ratio. The Sharpe ratio is a metric used to assess the risk-return of a portfolio or a specific asset. It measures the excess of return over the risk-free rate relative to the total risk of an investment.

$$\text{Sharpe Ratio} = \frac{R_p - R_0}{\sigma_p} \quad (2)$$

R_p - portfolio (or asset) return;
R_0 - risk-free rate (the return rate of bonds with a long-term maturity is usually used);
σ_p - the standard deviation of a portfolio's (or asset's) return.

This ratio compares the level of return an investor receives with the level of risk he takes and takes into account the risk-free rate, which is considered the main relative measure [22]. The higher the value of the Sharpe ratio, the better the investor compensates for the risk by accepting this level of profitability in the portfolio. Practically, the maximization of the Sharpe ratio was also carried out through the "Solver" add-on. Maximization of the Sharpe ratio allows finding optimal combinations of investment portfolios.

In the realm of finance and investment, several indicators exist to assess the capital requirements of investors for risk coverage. The two primary indicators are Value at Risk (VaR) and Conditional Value at Risk (CVaR). Both indicators serve critical roles in risk management, but they offer different perspectives and insights into the risk profile of an investment portfolio. VaR is a widely used risk measure that quantifies the maximum expected loss over a specified time period at a given confidence level. Essentially, it answers the question: "What is the worst loss I might expect to see on this investment over a given time period?" VaR is popular for its simplicity and ease of interpretation. However, it has limitations, primarily because it only gives information about potential losses up to the confidence level and does not provide insights into the severity of losses that could occur beyond this threshold. A certain extension of VaR is CVaR. Conditional Value at Risk (CVaR) also known as Expected Shortfall addresses some of the limitations of VaR. It calculates the average loss that could occur beyond the VaR threshold, essentially providing an estimate of the expected loss in the worst-case scenarios that exceed VaR. CVaR gives a more comprehensive picture of tail risk, offering insights into the potential severity of extreme losses. While VaR remains a fundamental tool in risk management, CVaR is often considered superior in terms of providing a more comprehensive and realistic view of potential risks, especially in the tail of the distribution where extreme losses reside. CVaR's ability to account for the magnitude of extreme losses makes it a more representative measure of risk for investors who are particularly concerned with the implications of worst-case scenarios. In our analysis, we opt to utilize CVaR for its more holistic approach to risk assessment. It not only captures the traditional risk metrics conveyed by VaR but also extends our understanding to the tail-end, high-impact events, which are crucial for a well-rounded risk management strategy. This choice is particularly pertinent in today's financial landscape, where market volatility and unprecedented events can significantly impact investment portfolios.

In the study, we have employed several methods to calculate Conditional Value at Risk (CVaR), each with its own principle of calculation. Here's a brief overview of each approach:

Historical Method (HM). This approach uses historical market data to estimate CVaR. It involves calculating the portfolio's return distribution based on historical price changes and then determining the CVaR as the loss corresponding to a pre-specified percentile of this distribution. For example, the 5th percentile CVaR is the loss that was exceeded only 5% of the time in the past.

Parametric Method (PM). Also known as the variance-covariance method, this approach assumes that asset returns are normally distributed. The CVaR is computed using the mean and standard deviation of the asset returns. This method simplifies the calculation by using the statistical properties of the normal distribution.

Cornish-Fisher Method (CF). This method is an extension of the parametric approach. It adjusts the CVaR calculated under the normal distribution assumption to account for skewness and kurtosis in the return distribution. This makes the CVaR estimate more accurate for distributions that are not perfectly normal.

The Monte Carlo Method in risk analysis involves using computer simulations to model the probability of different outcomes in a process that cannot easily be predicted due to the intervention of random variables. It is a technique used to understand the impact of risk and uncertainty in prediction and forecasting models. By running simulations repeatedly and randomly changing variables, the Monte Carlo Method provides a distribution of outcomes. In the context of CVaR, it helps in estimating the potential losses in a portfolio by simulating various market scenarios and calculating the average worst-case losses, making it a powerful tool for capturing the tail risk in complex portfolios.

GARCH Approach. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is used to forecast future volatility based on past volatilities and returns. The model accounts for volatility clustering, a common phenomenon in financial markets. CVaR is then calculated using this forecasted volatility.

EWMA Approach. The Exponentially Weighted Moving Average (EWMA) model is another method to forecast volatility. Unlike GARCH, EWMA gives more weight to recent observations while not completely discarding the older data. This model is often used for its simplicity and effectiveness in capturing the changing volatility [23].

Paired Copulas Constructions Approach. This method involves using copulas to model the dependence structure between different assets in a portfolio. By understanding the joint behavior of asset pairs, this approach provides a more detailed and nuanced view of the portfolio's risk profile. The CVaR is then calculated based on the modeled dependencies [24].

Each of these methods has its strengths and weaknesses and may be more suitable for different types of data or investment strategies. In practice, a combination of these methods can be used for a more robust risk assessment. For each portfolio and each approach at the confidence levels of 95% and 99%, we calculated the Conditional Value at Risk (CVaR) and compared these indicators with the corresponding figures for the years 2020 and 2021. This comparison was crucial in understanding the dynamics and effectiveness of various risk management strategies under different market conditions. For each portfolio and level of confidence, we identified three approaches where the deviation was the smallest. This analysis provided valuable insights into which methods were most effective in mitigating risk while maintaining portfolio performance, especially in volatile market scenarios. This approach underscores the importance of adapting risk management strategies to varying market conditions and highlights the benefits of a flexible, data-driven approach to investment decision-making. Three best approachs for each portfolio are displayed in Table 2.

Table 2

The results for each level of confidence and type of portfolio (calculated by the author)

	Low Risk Trad.	Low Risk Alter.	Low Risk Crypt	Low Risk Combo	Low Risk Combo + Crypt	Optim. Trad.	Optim. Alter.	Optim. Crypt.	Optim. Combo	Optim. Combo + Crypt
2020 with 95%	GARCH	GARCH	PM	GARCH	GARCH	GARCH	GARCH	PM	GARCH	GARCH
	EWMA	EWMA	Copula	EWMA	EWMA	EWMA	EWMA	Copula	EWMA	EWMA
	CF	Copula	HM	CF	CF	CF	Copula	HM	CF	CF
2020 with 99%	CF	Copula	CF	Copula	Copula	GARCH	Copula	CF	Copula	CF
	GARCH	CF	Copula	CF	CF	CF	CF	Copula	CF	Copula
	EWMA	HM	HM	HM	GARCH	HM	HM	HM	HM	HM
2021 with 95%	Copula	GARCH	PM	GARCH	GARCH	Copula	GARCH	Copula	GARCH	Copula
	HM	EWMA	Copula	EWMA	EWMA	HM	EWMA	PM	EWMA	CF
	CF	Copula	HM	CF	CF	CF	Copula	HM	CF	EWMA
2021 with 99%	Copula	CF	PM	CF	CF	Copula	CF	GARCH	CF	GARCH
	HM	Copula	GARCH	Copula	Copula	EWMA	Copula	Historical	Copula	HM
	EWMA	HM	HM	GARCH	GARCH	HM	HM	Copula	HM	Copula

For the crisis year of 2020 and at a 95% confidence level, regression analysis methods like GARCH and EWMA demonstrate the smallest deviation. This is due to these methods being based on autoregressive analysis and giving more weight to the latest values in the time series, which can enhance short-term forecasting accuracy. With an increase in the confidence level, the pair copulas constructions method shows the highest accuracy in estimating the investor's capital needs for risk coverage. This is attributed to the advantage of this approach in identifying dependencies in the tails of distributions. In analyzing differences in the stable year of 2021, the use of the copula approach becomes even more justified compared to the crisis period. The trend of increasing appropriateness of using the copula-based approach with higher levels of confidence continues into the post-crisis period. Notably, this approach also shows high accuracy for portfolios involving cryptocurrencies, indicating its effectiveness for combinations of assets with low correlation [25].

Conclusions from this study and prospects for further research in this direction

Evaluating investors' capital needs for covering risks is a critical aspect of modern portfolio management. The most representative indicator assessing this need is Conditional Value at Risk (CVaR). CVaR provides a more comprehensive risk measure than traditional methods by considering the magnitude of potential losses in worst-case scenarios, rather than just the probability of their occurrence. This makes CVaR particularly relevant for today's complex investment landscapes, where understanding and preparing for extreme market events is vital for effective risk management and informed decision-making.

In our assessment, we evaluate assets based on 10 portfolios: 5 constructed on the principle of minimizing risks and 5 optimized based on the principle of return per unit of risk. These 5 portfolios represent traditional assets, alternative assets, cryptocurrencies as a separate category, and combinations of these assets. This diversified approach allows for a comprehensive analysis of different investment strategies, assessing both the risk-averse and risk-adjusted return perspectives across various asset classes.

We evaluated capital requirements represented by Conditional Value at Risk using various methods, including Historical Method (HM), Parametric Method (PM), Cornish-Fisher Method (CF), Monte Carlo Method, GARCH, EWMA, and paired copula constructions method. Our analysis identified unique strengths of each method depending on portfolio structure and market conditions. Notably, autoregressive methods GARCH and EWMA were highly accurate for short-term forecasting in the volatile market of 2020. Conversely, paired copula constructions methods excelled at higher confidence levels and in cryptocurrency-inclusive portfolios, demonstrating their effectiveness in detecting complex inter-asset dependencies, especially in distribution tails. These findings underscore the importance of selecting appropriate methods for specific investment contexts and goals, offering deeper insights into both traditional and innovative risk management approaches in investment portfolios.

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